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7 August 1980

USSR Report

CONSTRUCTION AND EQUIPMENT

(FOUO 8/80)

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USSR REPORT

CONSTRUCTION AND EQUIPMENT

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CONSTRUCTION

ECONOMIC EFFECTIVENESS OF CAPITAL INVESTMENTS

Moscow VOPROSY EKONOMIKI in Russian No 6, Jun 80 pp 34-43

/Article by M. Chentemirov: "Ways of Increasing the Economic Effectiveness of Capital Investments"/

/Text/ Construction in our country has become a most important sector of the national economy. It has a decisive influence on the development and distribution of productive forces, the increase of the production potential of the country and the assurance of a steady increase of the standard of living of the people.

In the past 25 year the volume of construction in the USSR has increased more than eightfold. In the amount of capital investments the USSR holds first place in the world, having exceeded the level of the United States, as well as of the FRG, England, France and Italy taken together. During the years of the Eighth Five-Year Plan the total amount of capital investments was 347.9 billion rubles, the Ninth Five-Year Plan--493 billion rubles, for the 10th Five-Year Plan it is envisaged in the amount of 621 billion rubles.

The increase of the amounts of construction has entailed a change in its structure and territorial distribution. The proportion of capital investments in the eastern regions has reached nearly 20 percent. The value of the equipment for production facilities increased to 46 percent. In all 68 percent of the capital investments in production construction are spent for the expansion, renovation and retooling of operating enterprises.

A material and technical base of construction has been created in the country and is constantly being strengthened. In construction and at construction industry enterprises there are about 160,000 excavators, more than 43,000 scrapers, over 161,000 bulldozers, nearly 200,000 traveling cranes, more than 1.15 million trucks and special vehicles and other construction and transportation equipment.

However, the achievements of capital construction could have been more appreciable. During the past years of the 10th Five-Year Plan it has not been possible to achieve an appreciable improvement in capital construction. L. I. Brezhnev at the November (1979) CPSU Central Committee Plenum indicated that "the construction periods are often prolonged. The unfinished construction has considerably exceeded the standards. Often resources are allocated for far from priority construction projects. Not only errors and regionalism, but also cases of obvious arbitrariness are occurring here."

A significant amount of metal products is not being delivered to construction organizations. In 1979 four construction ministries alone (the USSR Ministry of Construction of Heavy Industry Enterprises, the USSR Ministry of Industrial Construction, the USSR Ministry of Construction and the USSR Ministry of Installation and Special Construction Work) were not supplied with 728,000 tons of rolled ferrous metal products (7.5 percent of the annual budget), including 586,000 tons of rolled products made from low-alloy steels, or 15.7 percent. Construction projects are also being unsatisfactorily supplied with cement, lumber, asphalt, limoleum and a number of other critical materials.

The imbalance is manifested first of all in the inadequate coordination of the plan assignments with the capacities of construction organizations.

The practice of the uneven distribution in the plan of the assignments on placing production capacities and fixed capital into operation by quarters of the year has not yet been eliminated. About 75 percent of the annual program of the placement of fixed capital into operation is planned for the second half of the year. This shortcoming has also not been eliminated in the plan for 1980.

This upsets the smoothness of the work of contracting organizations, leads to the nonfulfillment of the assignments on the placement of facilities into operation and is conducive to the appearance of large amounts of unfinished construction.

The number of new construction projects, which are included simultaneously in the plan, continues to remain enormous. For example, in the 1979 plan the number of production construction projects alone came to nearly 41,000, of them the newly begun construction projects constitute a significant share (more than 10,000). Moreover, in excess of 37,000 more enterprises, for which the construction or renovation of facilities is envisaged, are included annually in the plan. In this case more than 35 percent are newly begun construction projects.

Thus, approximately 78,000 production construction projects, including 30 percent which are being newly begun, are at the stage of construction or renovation (expansion).

As a result due to the inclusion in the plan of such a number of newly begun construction projects not enough capital investments for start-up construction projects at the same time are not being provided. For example, in 1979 they failed to receive in excess of 2.5 billion rubles. The construction periods are being prolonged, the standards of duration are not being observed and the national economy is not receiving that impact in the form of additional products, which is stipulated in the plans for the construction of enterprises.

In 1979 of the total number of new construction projects 24.4 percent were construction projects, for which the standards of the duration of construction had been surpassed. In order to complete them nearly 4.5 years will be additionally required. The proportion of new construction projects with elapsed standard terms of the duration of construction is even more significant in the USSR Ministry of the Gas Industry (42.8 percent), the USSR Ministry of the Chemical Industry (42.6 percent), the USSR Ministry of the Atuomotive Industry (38 percent), the USSR Ministry of the Petroleum Refining and Petrochemical Industry and the USSR Ministry of Ferrous Metallurgy (31 percent), for the completion of which from 2.5 years in the Ministry of the Gas Industry to 13.5 years in the Ministry of the Automotive Industry will be additionally required on the condition that henceforth the capital investments will be allocated at the level of preceding years.

For a number of years the level of unfinished construction has remained high and from year to year has increased, reaching in 1979 91 percent of the amount of state capital investments, or 104 billion rubles. The excess of the standard level was 24 points, or 27.3 billion rubles. At the same time it should be noted that during different periods of time the fluctuations of the amount of unfinished construction have been very significant. Thus, starting in 1957 a tendency toward a steady decrease of the level of unfinished construction was noted, and by 1964 it was 16 points. Since 1965 the level of unfinished construction has increased from year to year, having reached at this time amounts which are almost equal to the annual amount of capital investments. The amount of unfinished design and surveying work is also significant. At the beginning of 1979 it was equal to nearly 9 billion rubles.

As a result of the prolonging of the periods of designing and construction the obsolescence of planning documents is occurring, therefore in excess of 18 percent of them are liable to being written off and about 13 percent are liable to thorough revision.

The increase of unfinished construction and the unsatisfactory fulfillment of the assignments of the state plan attest that ministries and departments are devoting inadequate attention to questions of capital construction and especially to such an advanced direction of capital investments as the renovation and retooling of operating enterprises. In the plan for 1979 their proportion was less than one-fifth of the amount of the capital investments in production facilities.

The work on the draft of the plan of capital construction for 1980 was carried out on the basis of the observance of the principles and provisions of the decree of the CPSU Central Committee and the USSR Council of Ministers of 12 July 1979. Attention was first of all devoted to the assurance of the concentration of capital investments at start-up and carryover construction projects, the acceleration of the placement of production capacities and facilities into operation, as well as the achievement of a balance between the outlined amounts of work and the material and technical resources. As a result it was possible to reduce the number of newly started construction projects with an estimated cost of up to 3 million rubles, the title sheets for which are subject to the approval of the USSR Council of Ministers. Thus, instead of 652 such construction projects 356 were included in the plan.

USSR ministries and departments and the councils of ministers of the union republics have also been ordered to reduce the number of newly started construction projects with an estimated cost of up to 3 million rubles.

At present the country has an enormous production and technical potential. At the beginning of 1979 the fixed capital was 1.54 trillion rubles, of them 1,006,000,000,000, or 65.3 percent, are for production purposes. The fixed production capital of the national economy during 1971-1978 increased 189.5 percent, in industry by 187.9 percent.

But in recent years a decline of the output-capital ratio has been observed both for the national economy as a whole and for industry. Such a situation is unquestionably connected with the increase of the capital-output ratio of the products being produced, which has been caused by the increase of the demands on the technical level, the mechanization and automation of production, by the increase of product quality, the improvement of the working conditions of the workers and the implementation of environmental protection measures. At the same time there are also serious shortcomings in the use of fixed production capital. The slow assimilation of the rated capacities at the enterprises put into operation and the unsatisfactory use of the available production capacities adversely affected the amount of the output-capital ratio.

One of the most important questions in construction is the provision of construction projects with a regular labor force. In connection with the considerable decrease of the number of young people, who are reaching able-bodied age, the balance of manpower resources has been upset somewhat, which has lead to the inadequate provision of construction with manpower. In 1979 the supply of a regular labor force was 98 percent of the planned supply.

The losses of working time are still great owing to shortcomings in the organization of construction work and the provision of construction with material and technical resources. According to the data of sample surveys, which have been conducted by standards research stations, in 1979 the intershift losses of working time on the average were 8.5 percent of the worked time for construction, 12.1 percent at the organizations of the USSR Ministry of Construction of Petroleum and Gas Industry Enterprises, 10.6 percent at organizations of the USSR Ministry of Rural Construction and 10.1 percent at organizations of the USSR Ministry of Power and Electrification.

The reduction of nonproductive labor inputs (hidden losses of working time), which in 1979 were equal on the average to 7.5 percent of the shift time, and in some ministries were even higher: 13 percent in the USSR Ministry of Rural Construction, 8.8 percent in the USSR Ministry of Construction, is a serious reserve of the economy of working time. These losses form mainly due to the violation of the technology of operations, the low quality of the components and materials delivered to construction projects, shortcomings in their storage and so on.

The extensive dissemination of the brigade contract method is one of the effective means of improving the use of the regular labor force in construction. In the first half of 1979 more than 70,000 brigades numbering nearly 900,000 workers worked according to this method. They performed 32.5 percent of the total amount of construction and installation work, while during the corresponding period last year they performed 28.1 percent of it. The brigades, which have been converted to the contract, exceeded the six-month assignment on the increase of labor productivity by 7.3 percent, reduced the planned cost of the work by 3.6 percent and provided an economy of assets in the amount of 249 million rubles. At the same time the efficiency of cost accounting brigades would have been higher, had they worked according to this method continuously for the entire year. Analysis shows that the brigades work on the contract only 60 percent of the working time. This happens mainly due to the inadequate preparation of production, and in a number of cases the underestimation by some economic managers of this advanced method.

In recent years the proportion of skilled workers employed in construction has increased. The need of construction for them is being met by on-the-job training (54.4 percent), the recruitment of graduates of vocational and technical schools (18 percent) and the hiring of skilled workers by construction organizations locally (27.6 percent).

However, the plans of the admission of young people and the training of young workers in the system of vocational and technical education are not being fulfilled. At many vocational and technical schools of construction specialization, as in previous years, the training of workers of nonconstruction occupations is continuing. The assignments on assigning skilled workers to construction are also not being fulfilled.

As a result the proportion of workers, who have graduated from a vocational and technical school, in the total number of workers engaged in construction and installation work and at auxiliary works in the past 10 years has decreased from 6 percent to 3.8 percent.

Demographic changes and the difficulties connected with them in providing construction in the next few years with a regular labor force require the considerable improvement of the work of construction ministries and departments and the system of vocational and technical education as a whole on the training of construction workers and the improvement of their use.

Scientific and technical progress in the national economy is making qualitative changes in the technical level of capital construction. The amounts and complexity of the construction and installation work of the industrial complexes and facilities under construction are increasing significantly. The unit capacities of the enterprises being built and their technical equipment are steadily growing. For example, in the chemical industry the capacities for the production of ammonia increased from 200,000 tons a year to 450,000 tons, sulfuric acid--from 180,000 tons a year to 500,000 tons; in ferrous metallurgy the unit volume of blast furnaces increased from 2,000 m^3 to 5,500 m^3; in the petrochemical industry the capacities of petroleum refining blocks increased from 2 million tons a year to 8 million tons.

The increase of the organizational and technical level of construction to a large extent depends on the quality of the drafting of the plans of the organization of construction (POS's) and the plans of the performance of operations (PPR's), which call for a shift to a new, higher level of production control and ensure the timely placement of capacities and facilities into operation, the fulfillment of the assignments on the increase of labor productivity and the considerable increase of the effectiveness and quality of construction.

In recent years some design institutes of Moscow, the Ukraine and the Urals have gained experience in the drafting of organizational and technological documents. The designers jointly with the builders are ensuring the high quality and timely preparation of the plans of the organization and the plans of the performance of operations for the construction of industrial complexes and facilities. The work of the Dnepr River region Main Administration for Construction and Planning of Industrial Enterprises of the USSR State Committee for Construction Affairs and of the construction organizations of the Ukrainian SSR Ministry of Construction of Heavy Industry Enterprises on ferrous metallurgy projects and the preparation by the All-Union Scientific Research Institute of Planning of Hydroprojects imeni S. Ya. Zhuk of the USSR Ministry of Power and Electrification of the organizational and technological documentation for the construction of the Kama Motor Vehicle Plant are positive examples in this area. However, there are few such examples. Moreover, the review of the plans of industrial enterprises and facilities by the Main Administration of State Experts of the USSR State Committee for Construction Affairs shows that the quality of the drafting of the plans of the organization of construction has decreased in recent years.

The increase of the technical level of construction largely depends on the methods of performing the operations, the organization of construction work, the provision with means of small-scale mechanization and standard sets of equipment, as well as the instruction of workers in advanced labor methods. The design and technological institutes and Orgtekhstroy trusts are taking an active part in solving these complex problems. They are also giving practical assistance to construction and installation organizations and enterprises of the construction industry in the introduction of new equipment and advanced technology and in the drafting of plans of the performance of operations.

In recent times construction and installation organizations and many Orgtekhstroy trusts have begun an intensive search for new, improved forms and methods of the organization of construction work. Much attention is being devoted to questions of the engineering and technological preparation of production. Such effective organizational methods as the block method of the designing, preparation, organization and management of the construction of complicated facilities and major industrial complexes have appeared.

The essence of the block method consists in the fact that the structurally and technologically dependent parts (blocks) are singled out within the start-up complex for the purpose of organizing a technologically sound amount of work and achieving in the shortest possible time the technical readiness, which is necessary for the independent testing and adjustment of individual production lines, departments and plants. The block method was elaborated and introduced for the first time at construction projects of the Ukraine, where there were built using it: the complex of the oxygen converter shop and the 3600 mills of the Azovstal' Plant, blast furnace No 9 of the Krivorozhstal' Plant, the Khartsyzsk Pipe Plant, the complexes for the production of ammonia at the Severodonetsk Azot Production Association, the Odessa Port Plant and other facilities. In all in 1978 35 projects and complexes were built according to this method. At most of them the period for the placement of the capacities into operation was shortened by up to six months and a substantial economic impact was obtained. According to the data of ministries and departments, during the 11th Five-Year Plan they are proposing to carry out the adoption of the block method at more than 100 complicated projects and major industrial complexes.

The effectiveness of this method is explained by the rational concentration and use of material, technical and manpower resources within the complex, the possibility of combining the operations for the complex by means of the organization of parallel flows, the precise coordination of operations within each block and for the complex as a whole, the development of a reliable automated system for the planning of the performance of construction and installation work and resources, for operations management and production control of the progress of construction.

The allocation of considerable capital investments for the development of the natural resources of the Far North and remote regions of the country is envisaged during the 10th Five-Year Plan and in subsequent years. In these regions it is expedient to carry out the performance of construction and installation work by the forces of mobile formations, which have been stationed in inhabited regions, with the regular travel of the shift workers to the construction projects (the special field effort method of construction). This method of construction in recent times has been used extensively in the development of oil and gas fields, the construction of petroleum and gas pipelines, compressor and petroleum-pumping stations, gas treatment plants, geological prospecting and lumbering operations.

At present the USSR State Committee for Construction Affairs jointly with the Ministry of Construction of Petroleum and Gas Industry Enterprises is performing work on the study and generalization of the gained experience of using the special field effort method of construction of facilities of the petroleum and gas industry for the purpose of preparing the appropriate recommendations on its further improvement and extension to other sectors of industry. According to the data of the Ministry of Construction of Petroleum and Gas Industry Enterprises, the use of this method of organizing labor in the regions of the North, Siberia and the Far East will make it possible to reduce sharply residential housing construction, which is expensive in these regions.

Complex goal programs of advanced organizational and technical solutions are being introduced at many leading construction projects with the participation of scientific research organizations of the USSR State Committee for Construction Affairs and Orgtekhstroy trusts. The long-term Promkompleks program at the construction site of the Ul'yanovsk Industrial Center and the long-term Oskol program at the construction site of the electrometallurgical combine are most significant in this respect. They are making it possible to increase labor productivity by 8-10 percent, to shorten the duration of construction by up to 10 percent, to improve the quality and in this connection to reduce subsequently the expenditures on the operation of buildings and equipment. The anticipated economic impact from the introduction of such complex programs should be 1.5-2 percent of the cost of the construction and installation work.

Such local goal programs of the introduction of effective technological processes for specific types of operations as the Termobeton, Pnevmobeton and Monolit programs, which were drafted and recommended by institutes of the USSR State Committee for Construction Affairs, are of great interest. The Termobeton program, for example, contains recommendations on the erection of various monolithic components in winter with the use of a thermosetting concrete form and systems of automatic temperature control equipment. The economic impact in the erection of concrete and reinforced concrete components will be (according to preliminary data) about 5 rubles per cubic meter of poured concrete.

In conformity with the Progress program by means of the extensive use of "dry blocks" and items made from plaster it is planned to increase considerably the output of decorators. For this the additional output of improved dry plaster, plaster panels, blocks produced by the extrusion method and so on is planned at construction industry and construction materials enterprises. The construction ministries are also implementing other long-term goal programs, which are aimed at increasing the organizational and technical level of construction.

In recent times large-block methods of the erection of buildings and structures, the preliminary assembly and consolidation of equipment, the combining of installation and special construction operations, mechanized and automated methods of welding have been used extensively.

The method of large-block installation of equipment weighing in excess of 250 tons using vertical boom and crane equipment, as well as hydraulic hoists has been further developed. For example, the installation of propylene columns weighing 500 tons was carried out at the Budenovsk Plastics Plant, a hydraulic press with an operating force of 15,000 tons and units weighing up to 500 tons--at the Volgodonsk Atommash Plant, a reaction vessel weighing 730 tons--at the Omsknefteorgsintez Production Association.

The methods of the preliminary assembly and subsequent sliding of units into the planned position are used widely. Thus, the preliminary assembly with the subsequently sliding of the unit of the gas scrubber weighing 620 tons was carried out at the Bakal Ore Preparation Combine, a head impact machine weighing 6,000 tons--at the Soligorsk Potassium Combine, the block of blast furnace No 1 weighing 14,000 tons--at the Western Siberian Metallurgical Plant. In 1979 alone with the installation of 885,000 tons of technological equipment in large blocks the USSR Ministry of Installation and Special Construction Work reduced the labor inputs by 480 men a year and obtained a saving in the amount of 80.5 million rubles.

The movement for the creation of model construction projects is of great importance. The USSR State Committee for Construction Affairs, the Central Committee of the trade union and the Scientific and Technical Society of the Construction Industry have announced the All-Union Inspection and Competition for the Best Organization and High Standard of Construction Work. The goal of the competition, which will be held annually (with the tallying of the results by the Day of the Construction Worker), is the improvement of the organization of construction work, the increase of its standards, the observance of technological discipline at construction projects, the increase of labor productivity and other technical and economic indicators.

Measures on the further mechanization and automation of construction work have to be implemented and the structure of the fleet of construction machinery has to be improved considerably. In the next five years it is necessary to increase the average unit capacity of the machinery in the fleet by 25-30 percent. In particular, it is planned to increase the capacity of the scoop of excavators from 0.51 m^3 in 1978 to 0.59 m^3 in 1985, the power of bulldozers respectively from 93.2 hp to 125 hp; the lifting capacity of crawler-mounted cranes--from 26.7 to 36.5 tons, the carrying capacity of trucks--from 6 to 7 tons. All this will make it possible to reduce significantly the number of vehicle and motor transport service personnel, whose number at present is more than 2 million.

One of the most important tasks of the improvement and increase of the effectiveness of construction is the increase of the results of scientific research and the quickest possible introduction of scientific and technical achievements in practice. In order to ensure further progress in construction it is necessary first of all to continue the work on the reduction of the weight of buildings and structures, the consolidation of components and items, the increase of the plant readiness, the elaboration of more efficient design solutions with the use of new materials and first of all efficient heaters, the increase of the level of mechanization and the improvement of the organization and technology of construction. This will create the conditions for the further increase of labor productivity and the reduction of the cost, materials-output ratio and labor-output ratio of construction. What is meant is that during the forthcoming five years an increase of the proportion of construction and installation work, which is performed using the achievements of science, technology and advanced know-how, by not less than 60 percent and of the production of new products in the construction components and materials industry by approximately 65 percent should be ensured.

Such an increase can be ensured only on the condition of the purposeful improvement of design decisions, for which it will be necessary to elaborate and introduce a new system of the evaluation of the technical level of design decisions and first of all according to such indicators as the labor-output ratio, the materials-output ratio, the proportion of the operations which call for the use of new equipment and so on.

In the construction industry the amount of construction of industrial enterprises within industrial centers with common facilities of the auxiliary works and managements (power, transport, repair and so forth), engineering structures and pipelines has to be increased, having ensured an increase of the proportion of this construction from 10 to 30 percent. This will make it possible to reduce the capital investments by 3-4 percent, the area of the construction in progress by 8-10 percent and the length of the roads and railroads by 15-20 percent.

In the designing of auxiliary production facilities (pumping, compressor, boiler and oxygen stations, maintenance stations of electric loaders and so on), industrial and agricultural enterprises, their interconnection with each other and with the main buildings, as a rule, will be stipulated, which will make it possible to save up to 50 million rubles a year, to reduce the grounds of enterprises and to shorten the pipelines and roads.

The construction of two-story buildings with technical lower floors for the location of warehouses, ventilation equipment, pipelines and so forth, especially for enterprises of those sections, in which production facilities with specific temperature and humidity conditions and the servicing of pipelines outside the production facilities are needed, will be expanded. The cost of construction will thereby be reduced by 10-15 percent and the adjusted expenditures by 20-30 percent, the area of the construction in progress will be decreased by 40-50 percent.

It is necessary to use more extensively in the plans the outdoor location of technological equipment, which makes it possible to reduce the cost of construction by 10-25 percent, to decrease the area of the construction in progress by 10-15 percent and to increase the explosion proofness of production.

In the designing of industrial facilities and in the production of construction components and technological equipment provision is made for the extensive use of large light-weight blocks, including construction and technological blocks, which consist of large installation units of supporting and enclosing construction components in combination with elements of the engineering and technological equipment, which reduces the labor inputs in installation to one-third to one-half; blocks of standard-unit technological equipment, first of all in the construction of projects of the petrochemical, chemical, food and medical industries, main petroleum and gas pipelines and water management projects, which shorten by 15-20 percent the period of construction of the projects and reduce by 10-15 percent the consumption of metal by the shortening of pipelines; blocks of the heat engineering equipment of boiler houses, which will make it possible to save annually up to 30 million rubles and to release more than 15,000 people who are engaged in installation.

In agricultural construction it is expedient to standardize and thereby to reduce the list of standard plans of production facilities. To use, as a rule, light-weight reinforced concrete, reinforced cement, asbestos cement, wood, metal, polymer and other components and items of a high degree of plant readiness. Production, delivery in complete sets and installation should be carried out by the forces of rural construction combines. This will make it possible to reduce sharply the duration of construction, the cost of construction per unit of production by 3-5 percent, the labor-output ratio by 12-15 percent, the consumption of materials by 10-12 percent, to improve the working conditions of the construction workers and to increase the durability of the buildings by 1.5-fold to 2-fold. The proportion of the construction of completely prefabricated buildings needs to be increased to 55 percent. Effective reinforced concrete components, as well as glass concrete components, which ensure a considerable reduction of the materials and labor inputs during their preparation and installation, should also be used extensively.

The plant production of wood panel houses and sets of wood parts for houses with walls made from local materials for rural housing construction has to be expanded and it has to be increased in 1985 to 8.55 million m^2 of total area. Here the houses should be supplied with engineering equipment with the necessary fasteners and accessories, as well as wood items for the out buildings.

In water management and reclamation construction it is envisaged to increase the use of polyethylene pipe in the ascending pipelines of irrigation and water supply, which makes it possible to increase the speed and quality of construction, the durability of the pipelines; to use extensively the ditchless methods of laying polyethylene, as well as steel pipe when constructing covered drainage and pressure irrigation systems, ditchless drain layers which are equipped with laser systems, and thereby to increase, for example, the speed of the laying of drains made from polyethylene pipe by two- to threefold, to obtain a saving of up to 20,000 rubles a year per set of drain layers; to increase considerably the proportion of covered drains and plastic pipe, which are laid by the ditchless method, in the total amount of construction of the covered drainage system.

As a rule, monoblock deep-well electric pumps will be used in the construction of pressure irrigation systems, which makes it possible to eliminate the construction of buildings of the pumping stations. The proportion of irrigation pipelines made from precast reinforced concrete pipe in the total amount of construction of irrigation pipelines will increase 1.5-fold.

In state and cooperative residential housing construction the proportion of large-panel and modular house building will be increased. According to estimates, by 1985 it is possible to increase its proportion to 60 percent. The changeover to the construction of large-panel apartment houses according to new standard plans with an improved layout and greater comfort will be expedited. The proportion of construction of prefabricated cultural and general buildings will amount to 33 percent.

Here it is necessary to carry out the work on the equipment and finishing of facilities, as a rule, by "dry methods," in the form of the installation of body-shell and sliding partitions, prefabricated blocks of bathrooms, built-in furniture, while it is necessary to perform the facing of walls with large plasterboard, fiber-plaster, plastic and slag-devitrified glass sheets, covering with polymer films with an adhesive layer, the laying of floors with linoleum on a heat insulating and soundproofing base the dimensions of the room, parquet boards and sheets, synthetic carpets, which will make it possible to reduce the period of the operations, decrease their labor-output ratio by 15-20 percent and considerably improve the quality.

Advanced economical pile and slab foundations and thin-wall subsurface structures will be used more extensively in the designing and construction of buildings and structures. Among them are foundations made from reinforced concrete driven and tamped piles in the form of light large slabs; subsurface structures with thin reinforced concrete walls, which are built by the "wall in the ground" method, and the sinking of the shafts in thixotropic casings; foundations and buried facilities with the use of ground anchors.

Large, light, thin-wall components made from high-strength heavy, light and foam concretes and brick; driven piles without the cross reinforcement of the shank, columns of one- and two-story buildings made from high-strength concretes, of effective cross sections for several stories with efficient butt joints; multihollow roof panels with light reinforcement; floors in imitation of steel shaped planking; modules of rooms, kitchens, bathrooms, elevator shafts and stairways; panel partitions; panels of roll-less and bare roofs; three-ply wall panels and so on should be used more extensively in construction.

The problems of the designing and production of steel components and items and their use in construction are acquiring a special significance under present conditions. There will become more widespread columns, trusses and beams of roofs made from wide-flange H- and T-bars, bent-welded sections and single angles, the use of which will make it possible to reduce the cost of 1 million m^2 of roofing by 2-3 million rubles, the labor-output ratio by

20-25 man-years, the consumption of steel by 4,000-6,000 tons; structural components of roofs made from rolled sections, the cost and labor-output ratio of the production and installation of which are substantially lower than similar components now being used; two- and three-ply panels of walls and ceilings; window and skylight frames made from thin-wall tubular and bent steel sections in combination with openers, which will make it possible to save annualy more than 100,000 tons of steel; large, acoustically highly effective panels of suspended soundproof ceilings.

The considerable increase of the amounts of construction require a higher rate of development of the industry of construction components and parts, as well as the improvement of the use of the production capacities of operating enterprises and first of all large-panel and modular house building. The overcoming of narrow departmental trends in this area, which are leading to the underutilization of the production capacities of operating enterprises, the increase of the need of capital investments for the creation of new enterprises and managements of the material and technical base of construction, the appearance of small, poorly mechanized works, ultra long-range shipments of components and materials and so on, is an important task. The increase of the technical level of production should ensure the improvement of product quality and a considerable increase of the degree of plant readiness of components and items.

One of the primary tasks of the construction materials industry is the meeting of the need of construction for new, advanced construction materials, including high quality, extra fast setting, stressing and colored cements, meltable roofing material, linoleum on a heat insulating and soundproofing base and carpeting for floors, backing films, large facing sheets made from plastics, plastic pipe and strapping items, sealers, plasterboard and fiber-plaster sheets, double glass panes, facing sheets made from slag-devitrified glass and other effective materials. It is necessary to develop more extensively the production of brick wall panels and blocks, local binders, alkaline slag binders with the use of industrial wastes and nonmetallic construction materials.

The achievements of construction also depend on a number of other sectors of industry and first of all metallurgy, the chemical industry and machine building. Meanwhile the sector is being inadequately supplied with rolled products made from steels of higher and high strength, stainless steels, paints and varnishes for protecting construction components against corrosion, superplasticizers for concrete mixes, synthetic resins, fiberglass materials, new highly productive equipment for driving tunnels, drilling holes in permafrost grounds for the piers of bridges, special motor transport, hydraulic dredges, underwater graders, floating cranes and so on.

The necessary conditions for the sharp increase of the technical level of construction, the growth of labor productivity and the improvement of the quality of the construction product can be created only as a result of the pooling of the efforts of the construction and industrial ministries and departments.

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CSO: 1821

METALWORKING EQUIPMENT

MACHINES OUTFITTED WITH NUMERICALLY PROGRAMMED CONTROL

Results, Future Progress

Moscow STANKI I INSTRUMENT in Russian No 5, May 80 pp 1-2

/Lead article: "Toward New Frontiers of Technical Progress"/

/Text/ The Soviet people with great political and labor enthusiasm have greeted the First of May, the day of international solidarity of workers in the struggle against imperialism, for peace, democracy and socialism. The Soviet government in accordance with the decisions of the 25th CPSU Congress is steadfastly pursuing a Leninist foreign policy, which is aimed at preserving peace throughout the world and supporting the just struggle of peoples for freedom, independence and social progress. The policy of peace that is being pursued by the nations of socialist cooperation and their joint struggle for detente and preventing world wide nuclear war are basic factors of international life and the primary pledge for the peaceful future of humanity.

On May 9, 1980, the Soviet people and all progressive mankind solemly marked the 35th Anniversary of the Victory of the Soviet people in WWII. The heroic victory over German fascisim was the outstanding political event of modern times.

For nearly four years under the leadership of the Communist Party the Soviet people pursued the great Victory. They proceeded stubbornly and purposefully in overcoming unseen difficulties and in sparing no effort and their very lives to overthrow the agressor. Victory over German fascism and then over Japanese militarism had an enormous influence on the postwar structure of peace. It significantly strengthened the international authority of the Soviet government and led to the formation of a world wide socialist system. The victory in WWII once again confirmed the invincible might of the world's first nation of socialism.

During the postwar years the Soviet Union moved forward and multiplied its economic and scientific-technical potential beyond measure. A developed socialist society has been created in the USSR and grandiose plans to create the material and technical base of Communism are being accomplished. The USSR now accounts for one fifth of the world's industrial production. The growth rates of Soviet industrial production are significantly exceeding similar indicators of the developed capitalist nations. The basic trends of the intensive and dynamic development of the Soviet economy are now the raising of the efficiency and quality of work and the achievement of the highest final national economic results with the fewest expenditures.

The steady growth of the economic and scientific-technical potential of the USSR and the increased opportunities of industry and agriculture have made it possible to significantly raise the standard of living. During the past ten years alone per capital real income has increased 1.5-fold. More than 108 million people (more than 40 percent of the population) have improved their housing conditions. The average monthly wage (considering payments and benefits from the public consumption funds) per worker was 224 rubles in 1979. Significant successes were achieved in the field of health care, culture, education and science.

The Communist Party of the Soviet Union, true to the Leninist principles of foreign policy, is doing everything it can to ensure the peaceful labor of the Soviet people and to preserve and maintain peace throughout the world.

The elections to the supreme soviets of the union and autonomous republics and to the local councils of workers' deputies, which were held in February 1980, were a most important political event in the Soviet Union. The elections once again confirmed the full and unanimous support of the Soviet people for the policies of the CPSU and the programs for the building of Communism that were worked out by the 25th CPSU Congress.

The working class, the farm workers and the intelligentsia fervently approve the fruitful work of the CPSU Central Committee for the further development of socialist economy, science and culture, for raising the material well being of the workers, and for strengthening peace throughout the world. The elections demonstrated the inviolable unity of the Party and people and was a true celebration of socialist democracy.

The years separating us from preceding elections were rich in events of enormous political importance and were marked by significant achievements in accomplishing the decisions of the 25th CPSU Congress and the subsequent plenums of the CPSU Central

Committee. During this period a gigantic production potential was created, which has made it possible to ensure the gradual development of the Soviet economy - the chief factor for the growth of the well being of the Soviet people and for the further raising of the Soviet defense capacity.

Nearly one third of the basic production assets have been modernized; and new large territorial-production complexes have come into being. The agrarian policy of the CPSU is steadily and purposefully being pursued. During the last four years agricultural gross product increased by more than 40 billion rubles. The average annual gross harvest of grain during this period was 209 million tons, which was almost 27 million tons more than the average annual harvest of grain in the Ninth Five-Year Plan.

Capital investments in the national economy during the first four years of the Tenth Five-Year Plan surpassed 500 billion rubles; national income increased by 16.2 percent as compared with the same period in the Ninth Five-Year Plan; real per capita incomes grew by almost 14 percent; and more than 423 million square meters of housing were commissioned.

All Soviet people perceived the speech of General Secretary Brezhnev at a meeting with voters in the Baumanskiy election district of Moscow as an urgent program of action at the modern day stage.

Of enormous importance in the further realization of the economic and social program of the CPSU are the decisions of the November (1979) Plenum of the CPSU Central Committee, and the rules and conclusions that were contained in Brezhnev's speech at the Plenum.

At the November (1979) Plenum of the CPSU Central Committee they discussed the results of the development of the national economy and with a Party adherence to principle they noted the existing shortcomings and indicated specific ways to eliminate them. The Plenum noted that the basic trends of the achievement of highest national economic results are the further raising of the level of managing the national economy, improving the economic mechanism and increasing the responsibility of managers at all levels for the fulfillment of the decisons that have been made, and strengthening labor, planning and state discipline at each sector of work. The mandatory fulfillment of the decisions of the November (1979) Plenum of the CPSU Central Committee is the main task for all enterprises and organizations of the USSR Ministry of the Machine Tool and Tool Building Industry (Minstankoprom).

Solemnly and with great political and labor enthusiasm the Soviet people marked the 110th Anniversary of Lenin's birth, having commemorated this historical event with great successes in socialist competition. The collectives of the enterprises and organizations of the Minstankoprom, having successfully fulfilled their anniversary socialist pledges, continue to work purposefully on fulfilling the pledges that they made for 1980. Thus, workers at the Leningrad Machine Tool Building Production Association imeni Ya. M. Sverdlov have decided to fulfill the assignments of the Tenth Five-Year Plan for volume of production and product delivery for export ahead of schedule (by December 15, 1980).

The fulfillment of the state plan for the concluding year of the Tenth Five-Year Plan and the creation of a production undertaking for the successful start of the Eleventh Five-Year Plan depends largely upon the further development of socialist competition in all collectives of the sector. To make socialist competition a more powerful factor for the ahead of schedule fulfillment of assignments for the drafting and assimilation of new equipment is the primary mandate of economic managers and Party, trade union and Komsomol organizations.

On 10 and 11 March 1980 in the CPSU Central Committee there was a meeting of the workers of Minstankoprom in connection with the passage of the CPSU Central Committee and USSR Council of Ministers Decree "Concerning the significant raising of the technical level and competiveness of the metal working, casting and wood working equipment and tools". The decree is a multi-plan document that opens a qualitatively new stage in the development of Soviet machine tool and tool building industry. The decree is directed at sharply increasing the technical level and productivity of the machine tools, forge and press and casting equipment and tools and significantly increasing the output of the more progressive forms of such equipment in the Soviet Union during the Eleventh Five-Year Plan.

At the present time the USSR has a powerful machine tool and tool building industry, which each year produces more than 300,000 metal cutting machine tools and forge and press and casting equipment. In the Tenth Five-Year Plan serious work was done to raise the productivity of the equipment that was manufactured and to change the structure of the manufactrued equipment toward increasing automatic machine tools, highly-productive presses and machines, automatic production lines, and machine tools with CHPU (numerically programmed control). With a growth in the total output of metal cutting machine tools as compared with the Ninth Five-Year Plan of 6.4 percent, the production of special, specialized, modular, high precision, heavy and unique machine tools, as well as automatic equipment, semiautomatic equipment and automated production lines is increasing by 25 to 60 percent, while the output of machine tools with CHPU will more than double. There has been a significant growth in the production of modern forge and press and casting, wood working equipment and tools.

However, in spite of the important achievements, the technical development of machine tool building is still being accomplished at inadequate rates. The structure and quality of the equipment that is being manufactured for metal working do not fully meet the tasks for the adoption into the machine building production of advanced technological processes that can provide the greatest growth in labor productivity, raising the coefficienty for the use of metal and improving the quality of machine building product.

The achievement of high technical frontiers, which were defined by the decree, wiil require a sharp increase in the production of the more progressive types of equipment, in particular by reducing the manufacture of outmoded kinds of machine tools. The creative collectives of the machine tool building industry must create nearly 400 essentially new kinds of metal cutting machine tools and forge and press and casting equipment during the Eleventh Five-Year Plan.

The decree calls for the rapid development of the production of the more improved kinds of tools. In accordance with this it is proposed to increase 2.3-fold the manufacture of tools that are outfitted with manysided plates, to increase 9.2-fold the manufacture of tools that have plates coated with wear resistant materials, to increase 2-fold the manufacture of cutting tools made of polycrystalline diamonds, boron nitride and other super hard materials, and to increase 3.2-fold the manufacture of tools for machine tools with CHPU and for automatic production lines. We must constantly work to reduce the consumption of metal in the equipment that we manufacture, to more extensively use welded constructions and the appropriate grades of rolled metal. Thus, the use of calibrated rolled metal for moving screws provides a more than 20 percent savings in metal. At the Kolomna Heavy Machine Tool Building Plant, the Novosibirsk "Tyazhstankogidropress" Plant imeni A. I. Yefremov, the Kramatorsk Heavy Machine Tool Building Plant imeni V. Ya. Chubar', and at several other plants the welding of unique parts is being assimilated. Moreover the weight of the parts is lowered by 20 to 25 percent; and the labor intensiveness of their mechanical processing is significantly reduced.

The program for the further development of machine tool building calls for the carrying out of important measures to create and modernize production capacities. Significant amounts of money are being allocated for these purposes. New plants will be built; and existing plants will be enlarged and modernized. At the same time personnel must be trained and the technological preparation of production must be accomplished.

At present in the organizations and at the enterprises of the Minstankoprom specific measures are being devised to fulfill the assignments established by the decree of the CPSU Central Committee and the USSR Council of Ministers "Concerning the significant raising of the technical level and competiveness of the metal working, casting and wood working equipment and tools". Many collectives are making socialist pledges aimed at fulfilling newm more complicated assignments for raising the technical level of their product.

All workers of the Minstankoprom with great inspiration have perceived the decree of the CPSU Central Committee and the USSR Council of Ministers and see it as a new manifestation of the constant concern of the Party and government for the development of machine tool building. The collectives of the enterprises and organizations of Minstankoprom are applying all their efforts and creative energy to fulfill the 1980 plan and the socialist pledges that they made.

Monitoring Devices

Moscow STANKI I INSTRUMENT in Russian No 5, May 80 pp 5-8

/Article by A.A. Batalin, A.I. Kamyshev and B.I. Cherpakov: "Basic Principles of Constructing a System for the Technical Monitoring of Machine Tools with CHPU"/

/Text/ One of the factors delaying the use of machine tools with CHPU is the relatively low coefficienty of their use (the work time of such machine tools for the control program is 40 percent of the available work time; * significant time losses are connected with breakdowns and the recovery of working capacity).

One way to increase the efficiency of operating machine tools with CHPU is the system of technical monitoring (STD). The creation of STD of machine tools with CHPU represents a complicated multifactor task that requires the systems approach for its solution. At the first stage of the creation of the STD for machine tools with CHPU it is advisable to determine the basic principles for its construction and lay out the overall structure. In analyzing available experience in operating machine tools with CHPU one can formulate the following basic principles of constructing an STD.

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* Automatic complexes of machine tools with CHPU with centralized control from a computer for processing housing parts. Moscow, NIIMash, 1977, 66 pages.

1. The STD according to functions, structure and utilization technical means must correspond to the level of production automation, in which the machine tools with CHPU are operated.

2. The STD of the individual machine tool with CHPU, which is built into the automated production facility (sector, shop, plant), must be included in the automated system of production control (ASUP) and be connected with other systems by means of information channels.

3. The STD must be a component part of the total system for controlling the machine tool with CHPU and be created on the same methodological and element base with the system and must have the capability of using common information channels for the entire control system.

4. The STD must provide efficient monitoring when adjusting and operating and when preparing for and performing planned repair of the machine tool (this article basically examines the methods of technical monitoring, that are used when operating the equipment).

5. To obtain diagnostic information maximum use must be made in the STD of the existing devices of the control system and provision for the functioning of the machine tool.

6. The CHPU system (including the system containing the computer) must have a self-monitoring system that is constructed with the use of test-programs.

Figure 1 shows a structural diagram of the informational connections of the STD of a machine tool with CHPU in an automated sector.

Experience in operating machine tools with CHPU shows that the STD should be made into five subsystems: "Control of the readiness of the machine tool to operate", "Operational cyclical monitoring", "Operational assembly monitoring", "Special monitoring methods", and "Monitoring of processing results".

The work of the three first subsystems is based on the use of means of control, made in the form of binary monitors of various kinds. The work of the two last subsystems is based on the use of multirange or analog monitors; in this case the functioning of an individual system of the machine tool or of its part can be described as transfer functions or as differential equations (these equations are solved on the computer). In monitoring the parameters we include the static and dynamic control, the removal of readings, their storage in memory and the constant statistical processing of the values received by this means.

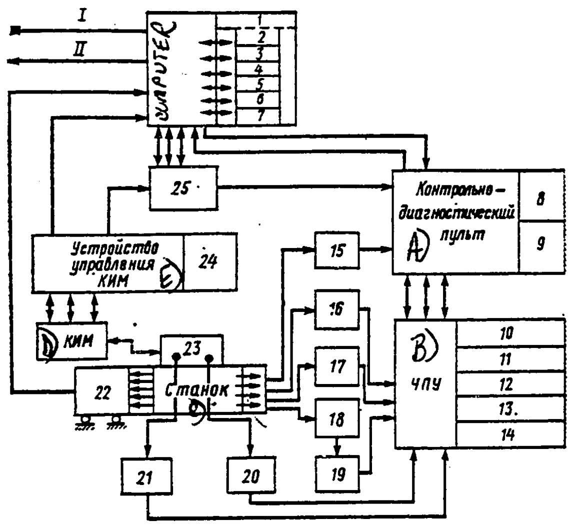

Figure 1.

Structural diagram of the information circuits of the STD of a machine tool with CHPU in an automated sector: I - In a system for monitoring the course of production; II - In a system for preparing the UP /programmed control/; 1 - External memory; 2 - Monitoring algorithms; 3 - Data bank on status of correct functioning; 4 - Test program monitoring bank; 5 - Current information storage; 6 - Special programs; 7 - Working data files; 8 - Readout of the basic conditions of the machine tool; 9 - Computer connection, test program call-up and telephone communications with service; 10 - Call-up and signal conversion from the means of technical monitoring; 11 - Storage of algorithms and mathematical support of the operational cyclical monitoring; 12 - Transfers of diagnostic information into the computer; 13 - Receipt from the computer of test programs and their processing; 14 - Feed of operational diagnostic information into the control-diagnostic panel; 15 - Means for controlling the readiness of the machine tool to operate; 16 - Means for operational cyclical monitoring; 17 - Means for operational assembly monitoring; 18 - Means of adaptive control; 19 - Signal conversion unit; 20 - Active control devices; 21 - Manual control devices; 22 - Equipment for special monitoring methods; 23 - Part; 24 - Processing of incoming information, determining the critical value of a part size, feed of diagnostic

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signs into the computer and the operating service; 25 - Operating service (KIM - control and measuring machine).

A - Control-monitoring panel
B - CHPU
C - Machine tool
D - KIM (control and measuring machine)
E - KIM control device

An automatic control of the preparation of the machine tool to operate (it checks availability of an ingot on the machine tool, of a tool in the magazine, the pressure in the hydrosystem, in the SOZH (cutting fluid) feed system and in the pneumatic system, cutting fluid in the tank, and the feed of lubricant to the appropriate assemblies) is placed in the subsystem "Control of the readiness of the machine tool to operate" (Figure 2). Correlated information concerning the readiness of the machine tool is removed to the monitoring panels of the machine tool and to groups of machine tools. Information concerning the reasons for the nonreadiness of the machine tool can be sent to the controller's panel. The following means of control are used in this subsystem: terminal circuit breakers, blocking relays, pressure monitors, floating relays and so forth.

The subsystem "Operational cyclical monitoring" provides generalized evaluation of the technical condition of the machine tool and also performs an operational search of the place and reason for a breakdown or malfunction in the functioning of the machine tool according to an assigned program with feed of information to the controller's panel; it also analyzes deviations from estimated values and forecasts changes in the technical condition of mechanisms and assemblies that are responsible for a given element in the cycle. It estimates the date and time of lost time for organizational reasons (waiting for ingots, tools and UP, etc.) and signals when a tool needs to be replaced. Terminal circuit breakers, relays, feed back monitors for position and machine tool control system timers are used as control means in this subsystem.

The work of this subsystem (Figure 3) is based on a principle that was developed by the ENIMS /Experimental Scientific-Research Institute of Metal Cutting Machine Tools/. This principle governs the control of the time of working and auxilliary processes on machine tools with CHPU. This controls the duration of the total cycle, the elements of the basic cycle (for example, turning the tool arm, turning the tilter of the tool, the indexing turn of the table, etc.), the elements of the combined cycle (for example, positioning of the tool magazine) and cutting.

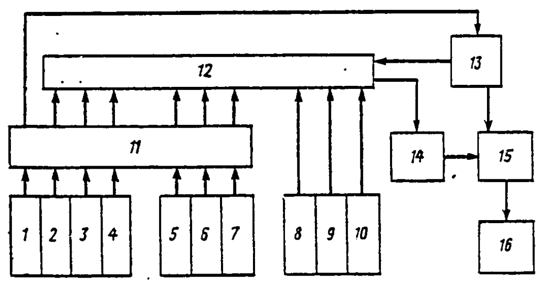

Figure 2.

Structural diagram of the STD subsystem "Control of the readiness of the machine tool to operate": 1 - Automatic circuit breaker of the machine tool; 2,3 and 4 - Blocking relays of the main drive, feed drives and auxilliary motion drives, respectively; 5,6 and 7 - Pressure monitors in the hydrosystem, cutting fluid feed systems and in the pneumatic system, respectively; 8 and 9 - Monitors of the level of oil and cutting fluid, respectively; 10 - Monitor showing presence of ingot; 11 - Monitoring panel of the machine tool; 12 - Signal switchboard; 13 - Monitoring panel of a group of machine tools; 14 - Signal coding device; 15 - Upper class computer; 16 - Controller's display.

The subsystem works in this manner. When preparing the programmed control they estimate (based on technological data) the duration $T_{\Sigma p}$ of the total cycle, τ_{ip} of the elements of the basic cycle, τ'_{ip} of the elements of the combined cycle and τ_{ipez} of cutting, which are registered in accordance with command addresses to the program carrier, for example on punched tape. On the basis of this information they also estimate the time of the use of each of the cutting tools and signals when it must be replaced.

The program carrier is fed into the device that reads the programmed control, from which information concerning the estimated duration of the cycle and its elements are fed into the comparison unit and information concerning the time of the use of the cutting tools is fed into a unit for estimating the work time of the tools.

During the functioning of the machine tool signals from the monitors of position of the working parts pass through a unit that controls the actual duration of the cycle elements; this unit can be made in the form of a control timer. The actual durations $\tau_{i\phi}$ and $\tau'_{i\phi}$ are fed into the comparison unit, where they are compared with the estimated durations τ_{ip} and τ'_{ip}. Information is fed into a unit for determining the actual duration $\tau_{\Sigma\phi}$, from which the obtained result is transmitted into a comparison unit and a device for output of information, as well as into a system for estimating and planning the course of production.

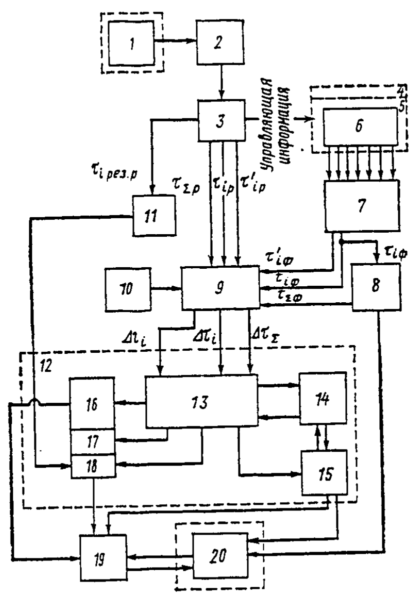

Figure 3.

Structural diagram of a subsystem STD "Operational cyclical monitoring": 1 - System for preparing the programmed control; 2 - Program carrier; 3 - Reading device; 4 - Machine tool with CHPU; 5 - Device for processing programmed control on the machine tool; 6 - Monitors showing position of the working parts of a machine tool; 7 - Unit for controlling the actual duration of the elements of a cycle; 8 - Unit for determining the total actual duration of cycle; 9 - Comparison unit; 10 - Tuned element; 11 - Unit for estimating work time of cutting tool; 12 - Information output device; 13 - Unit for encoding information; 14 - Code table of malfunctions and probability of their happening; 15 - Unit of integral evaluation of the condition of the machine tool according to $\Delta\tau_\Sigma$, $\Delta\tau_i$ and $\Delta\tau'_i$;

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16 - Display panel; 17 - Display showing reasons for breakdown; 18 - Command to replace tool; 19 - Operational service; 20 - System for estimating and planning course of production: $\tau_{i\,p\text{e}з}$, τ_{ip}, τ'_{ip} and $\tau_{\Sigma p}$ - estimated durations of cutting, element of basic cycle, element of combined cycle and total cycle, respectively; $\tau_{i\phi}$, $\tau'_{i\phi}$ and $\tau_{\Sigma\phi}$ - actual durations of the basic cycle, element of the combined cycle and total cycle; $\Delta\tau_i$, $\Delta\tau'_i$ and $\Delta\tau_{\Sigma}$ - deviations in the actual duration of the element of the basic cycle, the element of the combined cycle and the total cycle.

The work algorithm of the device for information output is constructed in the following manner. When the information encoding unit receives a signal to the effect that the duration of a cycle element exceeds what is permissible (this equates to a "malfunction" or "breakdown" situation in one of the cycle elements), the display panel lights up the location of the malfunction or breakdown in an encoded or alphanumeric form. The reason for the malfunction is determined automatically according to a preliminary logical analysis or by an operator (a representative of the operations service) on a table of malfunctions.

The subsystem "Operational assembly monitoring" (Figure 4) is used to diagnose when the subsystems "Control of readiness of the machine tool to operate" and "Operational cyclical monitoring" are unable to perform this task; it is used primarily when the machine tool is not functioning properly. The assemblies and systems, which support the functioning of the machine tool, are the objects of the monitoring; test programs are used as the means of control for monitoring of the lower rank computer, the means of signal output from the device for controlling the feed drives, the main motion and electroautomatic equipment of the machine tool and the computers of the lower and upper rank.

The monitoring is performed according to an absolute algorithm. For this on the command from the monitoring panel the assembly switchboard switches the malfunctioning assembly to query its control points. From the control points the signals pass through the signal coding device, where based on a comparison of signal levels with the established limits these signals are converted into logic zeroes and ones.

At the same time a command is fed to the call-up for selecting the fixed combinations of codes, which correspond to the control points of the assembly, from the external memory device (VZU) of the lower rank computer. According to the results of the comparison the matched combinations are formed. The reason for the breakdown and recommendations for eliminating it are shown on the screen of the operator's display unit. When the CHPU device malfunctions, which is installed on the base of the lower rank computer, the computer monitors itself; when this cannot be done the upper rank computer is switched on.

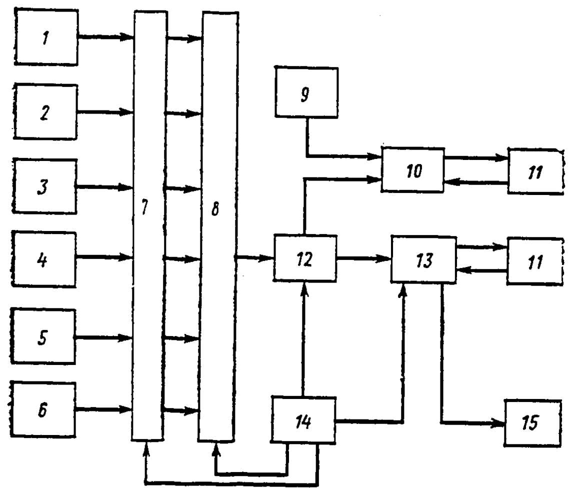

Figure 4.

Structural diagram of a STD subsystem "Operational assembly monitoring": 1,2,3 and 4 - Devices for replacing tool, clamping the tool and replacing the ingot and clamping the ingot, respectively; 5 - Feed drives; 6 - Main motion drive; 7 and 8 - Switchboards for the assemblies and signals, respectively; 9 and 14 - Monitoring panels of a group of machine tools and a machine tool, respectively; 10 and 13 - Computers of the upper and lower ranks, respectively; 11 - Computer external memory units; 12 - Signal encoding device; 15 - Operator's display.

The subsystem "Special monitoring methods" is used to perform complicated operations of monitoring using special tests and devices, the presence of which on the machine tool for technical and economic reasons is inadvisable. The subsystem is used when the operational monitoring does not make it possible to establish the reason for the machine tool not functioning properly and also to forecast the working capacity of the machine tool and performing preventive work for technical servicing.

In contrast to the subsystem "Operational assembly monitoring" in this subsystem the monitoring is performed primarily by using analog signals of working processes that take place in the machine tool and also the signals from monitors that are built into the machine tool. Both the electrical and the mechanical parameters of the systems and assemblies of the machine tool are analyzed. As a rule, monitoring is carried out according to an arbitrary algorithm, i.e., each subsequent check is set considering the results of preceding checks. In this subsystem the following means of control are used: the switching electrical instruments, built-in guages of mechanical parameters, an installed control and measuring rigging, test programs for controlling the machine tool, equipment for the output and registration of diagnostic information, and an upper rank computer.

Due to the setting of differentiated norms for various signals, statistical processing, spectral analysis and other forms of data processing, the subsystem defines and analyzes the technical characteristics of the machine tool which affect its working capacity (precision of positioning, the precision of the circumvention of a contour, the frequency characteristics of the drives and the carrier system, the geometric precision of the machine tool, and so forth). The subsystem controls the mechanical parameters of the elements of the design of the machine tool as well (the rigidity of the kinematic pairs, the clearances, the force of friction, wear and so forth). Additional installed devices and instruments for the initial processing of signals are installed on the skid-base and are connected with the machine tool by channels of communication.

An upper rank computer is used for the monitoring. The required test program for controlling the machine tool is summoned from the external memory device and transmitted to the lower rank computer. At the same time the reference values of the signals and the programs for their processing are retrieved from the external memory device. The signal switchboard (for inputting the latter into the analog-digital converter) is controlled manually or automatically (through the feed of commands from the lower rank computer in accordance with the test program for controlling the machine tool). The obtained diagnosis is fed to the operator's display panel. As concerns the direct input of the experimental data into the computer of the upper rank it is possible to use an intermediate carrier of information in the form of magnetic tape of punched tape. This method is somewhat more simple than what has been described, but it is less effective.

During preventive maintenance checks the obtained characteristics of each machine tool is stored in the external memory device of the upper rank computer, where also information is kept about the time of operation and the repair of assemblies and systems of the machine tool. Based on the analysis of the changes in the characteristics and their comparison with the normative values the predict the probability of maintaining the working capability of the machine tool for a certain period of time.

The basic task of the subsystem "Monitoring according to processing results" is to control the changes in the status of the assemblies of the machine tool, which affect the precision of the parts that are processed. This subsystem is particularly important for the technical monitoring of machine tools with CHPU for finishing processing. In this case the errors in geometry of the machine tool and its change under external factors (fall in the temperature of the air and floor, deviations in the foundation, etc.), wear of the moveable assemblies, the heating of base parts, etc., are basically copied on the part being processed.

The results of tests performed at the Experimental Scientific-Research Institute of Metal Cutting Machine Tools on MA690MF4 model machine tools demonstrated that the information that is obtained when measuring marts following finishing work has several diagnostic indications. For example, during the finishing work of a surface using a face cutter, equipped with cutting tools made of elbor, on the surface of the part being processed was "imprinted" that which at the high frequency of revolution of the spindle (n 1000 RPM) under the influence of thermal separation from the supports of the spindle the axis of the latter is displaced relative to the directing (a lengthening of the spindle takes place in the direction of the part and its angular displacement).

Within the limits of time of processing of the surface the lengthening of the spindle took place at a speed of $\delta = \Delta s/B$ = 6 micrometers per minute. The angle of deviation of the axis of the spindle under the effect of thermal deformations at the end of processing was α =arctg $[h/D_{fr} 1000]$. Here Δ is the nonrectilinearity of the surface being processed in micrometers; s - is the feed in millimeters per minutes; B - is the width of the part in millimeters; h - is the depth of the tread obtained when milling in several passes along the height of part in micrometers, and D_{fr} is the diameter of the cutting in millimeters.

Consequently, if following this processing the error in the surface exceeds what is permissible, it is necessary to check the supply of lubricant to the ballbearings of the spindle, the temperature of the oil in the lubricating system, the correctness of the regulation of the clearance in the bearings of the forward support.

The analysis of the change in parameters in time makes it possible to predict the advancement of the critical condition of the machine tool and to plan timely technical servicing or repair. One of the methods for predicting an emergency situation or the need for servicing is examined in the work cited below. * This method is based on determining the fact of the outcome of the drift curve of the centers for grouping the controlled size (for example, the size of an opening being bored) within its maximum value. The cited structure of the STD predetermines the sequence of monitoring the technical condition of a machine tool with CHPU. (Figure 5)

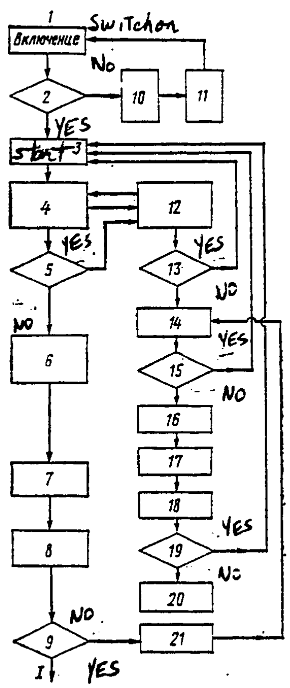

Figure 5. Algorithm of sequence for monitoring the technical condition of a machine tool with CHPU. 1 - Subsystem "Control of readiness of machine tool to operate"; 2 - Is there a signal showing readiness of machine tool to operate; 3 - Machine tool starter; 4 - Switch for turning on the the subsystem "Operational cyclical monitoring"; 5 - Is there a "Breakdown" signal; 6 - Continuation of functioning; 7 - Removal of finished part; 8 - Control of part on the KIM /control and measuring machine/; 9 - Is there a signal "Part is useable"; 10 - Summons to the control-monitoring panel; 11 - Elimination of malfunction; 12 - Search for place and cause of breakdown; 13 - Is there a signal "Breakdown eliminated"; 14 - Switching of the subsystem "Operational assembly monitoring"; 15 - Is there a signal "breakdown eliminated"; 16 - Service call; 17 - Switching of the subsystem "Special monitoring methods: 18 - Carrying out of monitoring; 19 - Is there a signal "Working capability established"; 20 - Decision making concerning performance of repair work; 21 - Switching of subsystem "Monitoring according to results of processing": I - Into the system for estimating the course of production.

Information of the diagnostic system can be used as initial data for other systems working within the automated production control system, in which are used machine tools with CHPU. For

* Kardanskiy L.L., Naydin Yu.V., Chudakov A.D.: Centralized control of machine building equipment from a computer. Moscow, Mashinostroeniye, 1977, 263 pages.

the system for estimating the course of production the STD can transmit the following information: actual duration of part processing on each machine tool and each operation, duration of standdowns for various reasons, productivity of each unit of equipment and prediction of the working capability of the basic assemblies of the machine tool.

Information concerning the duration of standdowns due to breakdowns, malfunctions, scheduled and unscheduled maintenance, frequency of malfunctions for each unit of equipment, etc., is fed into the system for estimating and analyzing the reliability of the equipment. Information concerning mistakes in programming, the need to change the processing mode (based on the analysis of the frequency of breakdowns of the cutting tool), the number of motions, and so forth is fed into the system for preparing the programmed control.

With consideration of the obtained diagnostic information these systems perform necessary estimates, on the basis of which the system of operational-calendar planning enters the algorithm of production control into the monitoring system.

A structural diagram of the STD connections with the ASUP /automated production control system/ is shown in Figure 6.

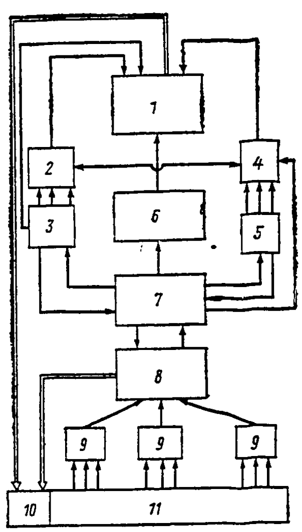

Figure 6. Structural diagram of the STD connections with the ASUP systems: 1 - Monitoring system; 2 - System of operational-calendar planning; 3 - System for preparing the programmed control; 4 - System for rating the course of production; 5 - System for rating and analyzing equipment reliability; 6 - Monitoring center; 7 - STD terminal; 8 - STD; 9 - Means for monitoring; 10 - Information panel; 11 - Production equipment.

Experience in using machine tools with CHPU, the analysis of the reasons for breakdowns and the time structure of using such machine tools demonstrate that the adoption of STD makes it possible to significantly increase the coefficient of using machine tools thereby raising their productivity. The economic savings from using STD and each of its subsystems can be determined according to the formula $E_g = Ts_1\ (1 - K_{up2}V_2 - K_{org})/(1 - K_{up1}V_1 - K_{org}) - T_{s\ 2} + /\overline{F}_n S/(R + Ye_n)\overline{/}\ X\ (K_{up1}V_1 - K_{up2}V_2)$, where E_g is the annual savings from using STD in rubles; Ts_1 and Ts_2 are the wholesale prices of the machine tool before and after adoption of the STD in rubles; K_{up1} and K_{up2} are the coefficients estimating the work of the machine tool according to programmed control before and after the adoption of the STD; V_1 and V_2 are the relative durations of restoration before and after the adoption of STD; K_{org} - is the coefficient that estimates organizational and technical losses; F_n is the nominal time fund under a two-shift system; Ye_n is the standard efficiency coefficient (Ye_n + 0.15); R is the norm of amortized deductions for equipment restoration (R = 0.053); and S is the cost of one hour of unscheduled repair in rubles.

The first two members of the formula estimate the savings from raising productivity by increasing the coefficient of use of the machine tool; the third member is the savings from reducing losses in expenditures for unscheduled repair work.

According to data cited below * the STD is compensated if, for example, the time of breakdowns of a multi-tool machine tool with CHPU is reduced by 10 to 20 hours per year altogether.

* Hollingum J. Regular check-ups for your computer can keep it on its feed. - Engineer (Gr. Brit), 1975, 240, N 6210, p 47 - 49.

New Line of Milling Machines

Moscow STANKI I INSTRUMENT in Russian No 5, May 80 pp 9 - 10

/Article by N.I. Ivanov, I.N. Solovyev and N.M. Syundyukov: "A New Group of Milling Machine Tools with CHPU for Processing Ships Propellers"/

/Text/ One of the most labor intensive operations in manufacturing one-piece propellers is processing rectilinear surfaces (blades and their plenum and suction surfaces, channeled transits and the external surface of the hub).

The Leningrad Special Design Bureau of Heavy and Unique Machine Tools has developed a line of milling machine tools with CHPU for processing the one-piece ships propellers with a diameter of D_v = 600 ÷ 4500 millimeters, which includes machine tools model KU350 (for D_v = 600 ÷ 1200 millimeters), KU351 (For D_v= 1000 ÷ 2500 mm) and KU352 (for D_v = 2000 ÷ 4500 mm). These machine tools are manufactured by the Kolomensk Heavy Machine Tool Building Plant.

The new line of machine tools can be used in by-unit, small-series and series production and are to be used for processing in an automatic mode of all rectilinear surfaces of a propeller, incuding the surfaces of the hub, the channeled transits and edge contours. The basic type of processing of the surfaces of blades is the face milling by maintaining a constant angle of the inclination of the milling to the surface being processed, by which the component cutting forces of R_x and R_z are directed along the blade of the propeller (toward the greatest rigidity). The remaining surfaces are processed by cylindrical and terminal cutters.

The component assembly of the line of machine tools is done considering the condition of the least departure of the tool holder with the milling heads. Departure is determined by the ratio of height h of the hub of the propeller to D_v. For propellers with a diameter of D_v = 600 ÷ 2500 mm h/D_v = 0.8 ÷ 1 predominates, while for propellers with D_v = 2500 ÷ 4500 mm h/D_v= 0.15 ÷ .5, therefore the machine tools models KU350 and KU351 have a radial input of the cutting tool and machine tool model KU352 is a vertical (axial).

Machine tools models KU350 and KU351 (Figure 1) are identical in design and are made according to the type of single-column machine tools with a revolving table 1 for the placement and securing of an article 2 (propeller). The mount 9 has mutually perpendicular guides, on which the sledges are installed 10, which carry the table 1, and the column 7. The column has vertical guides; on which are installed the skids 6, which support the drive drill chuck 8, which can turn in a vertical plane.

Within the casing of the drill chuck 8 is installed (on sliding bearings) a bushing, on the forward face of which is secured the tool holder 5, which bears a replaceable spindle head 4 with the cutter 3. Within the bushing there is a drive shaft, which transfers the revolution from the electric motor of the main drive to spindle of the head 4.

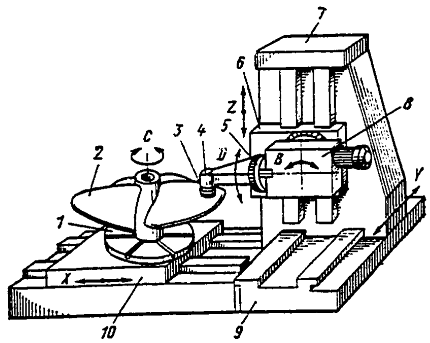

Figure 1. Diagram of a Model KU351 Machine Tool

These machine tools work in the following manner. The revolution of the table 1 displaces the surface of the propeller being processed .2 in relation to the cutter 3. The displacement of the drive drill chuck 8 to the cutter transfers motion in a vertical direction (in respect to the profile of the propeller blade in a given section). At the same time the tool holder 5, and consequently, to the spindle box with the cutter is sent the revolution around the lengthwise axis, which results in the cutter being perpindicular to the surface being processed. For transferring to the sledge 10 a periodical feed is supplied. During processing by displacement of column 7 the cutter is displaced from the center of the propeller 2, thereby ensuring constancy in the line width.

In contrast to machine tools models KU350 and KU351, machine tool model KU352 (Figure 2) is a non-moving table 9 and a column 2, having a cross bar 4 with horizontal guides. On these guides are installed a sledge 5 with a vertical slide bar 3. On the lower face of the slide bar a turning spacer 6 is installed, the mooring surfaces of which are placed at a 15 degree angle to each other. To the lower surface of the spacer 6 is attached a drill chuck 7, within which is placed a turning bushing. On the forward face of this bushing are installed replaceable spindle boxes 1 with cutters 8.

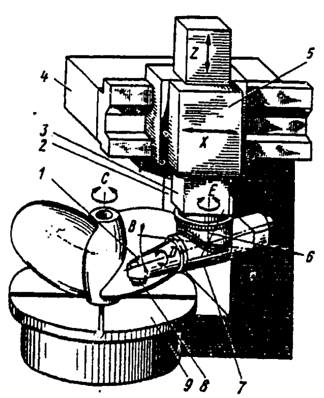

Figure 2. Diagram of a Model Machine tool

The spacer 6 can be turned in relation to mooring surface of the slide bar 3 that is connected with it, and the drill chuck 7 can be turned in relation to the slanted mooring surface of the spacer 6, which makes it possible to change (in a vertical plane) the angle of inclination of the lengthwise axis of the drill chuck 7 and to install the cutter in relation to the radial slant of the blade. Turning the spacer 6 only in relation to the upper mooring surface puts the lengthwise axis of the drill chuck 7 and the cutter in such an angular position in an horizontal plane, which ensures passes of the spindle box 1 in the inter-blade space of the propeller.

The spindle drive is accomplished from the electric motor through the two-stage speed box and the drive shaft, that is located in the bushing. Machine tool model KU352 works in the same way as models KU350 and KU351 with the single difference that the feed to another line is done by the movement of the sledge, and the displacement of the cutter from the center of the article is done by turning the spacer.

The necessary values of displacing the assemblies of the machine tools of this line during their operation are supplied by a program written on punched tape, from a CHPU device type N55-2.

On machine tools models KU350 and KU351 CHPU control is done in accordance with five coordinates (See Figure 1): X - displacement of the table; Y - displacement of the column; Z - displacement of the drill chuck; S - revolution of the table; D - revolution of the bushing with the tool holder. Coordinate V is the turning of the drill chuck is adjustable; displacement is accomplished manually (using a scale).

On machine tool model KU352 the CHPU control is performed in accordance with four coordinates (See Figure 2.): X - the displacement of the sledge; Z - displacement of the slide bar; D - turing of the bushing with a head; S - the turning of the table. Coordinates Ye and V - the turning of the drill chuck in horizontal and vertical planes are adjustable; displacements are done manually (using a scale).

On machine tools of this line all coordinates, that are controlled by a CHPU, have a digital display, and linear coordiates X, Y and Z also have zero creeps.

DC electric motors with a broad range of regulation are used as main drives, which in combination with the two-stage speed boxes and three types of replaceable spindle boxes provide for the processing of all these surfaces of propellers made of various materials.

In the feed drives they use DC electric motors with a power supply from thyristor converters. The feed drives of linear coordinates X, Y and Z contain reducers with a transmission ratio of 1 : 7.5 and ball-type pairs of propeller to screw of 100 X 12 mm. The feed drives of the circular coordinates S and D have terminal linds - worm pairs with a variable screw. For feed back monitors they use revolving transformers of the VTM-1V type.

Tests of the KU350 machine tool (on specimens) have demonstrated the stable cutting and required (± 0.1 mm) processing accuracy, inspite of a significant (750 mm) departure of the tool holder. In Figure 3 we see a profilogram of a round specimen that was processed on a KU350 (with a non-moving table, by means of movements along the X and Y coordinates) by means of terminal cutting with a diameter of 50 mm, six teeth made of R18 high-speed cutting steel. Processing mode: cutting depth of 10 mm; cutting width of 15 mm, and cutting speed of 40 meters per minute. The radius of the equidistance is 160 mm; and the specimen was made of steel 45 (NB 170).

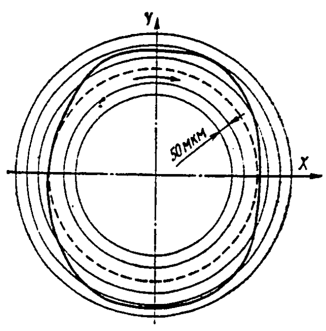

Figure 3. Profilogram of a circular specimen processed on KU350 machine tool. The solid line is the processed contour. The broken line is the assigned contour (the arrow shows the direction of contour by-pass).

As you can see, the greatest error in processing occurred in the direction of the Y coordinate; this error was caused by a transverse deflection of the tool holder from the force of cutting. The affect of the dynamic error of the machine tool's feed drives on processing accuracy is insignificant. The surfaces of the propellers generally have smooth contours and allowances for processing vary only slightly. This results in a constancy of the curve angle of the tool holder, which in turn raises processing accuracy.

The described machine tools make it possible to process propellers with a constant and variable step; while forming blades it can have an inclination of up to 75 degrees and a variable curvature.

The use of face milling in combination with programmed control along four to five coordinates inproves cutting conditions and raises the durability of the tool and the productivity and stability of the form of processed surfaces; it reduces their roughness and, as a consequence, improves the operating characteristics of propellers.

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